

Spring calculation

1. Calculation of spring constant:

The vibrating mass m is calculated from the weight of the trough plus twenty percent of the weight of the load, distributed over n support points:

$$(1) \quad m = \frac{m_1 + 0.2 \times m_2}{n} [kg]$$

For systems whose working frequency f is close to the resonant frequency, the following applies:

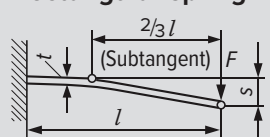
$$(2) \quad f [Hz] = \frac{1}{2\pi} \times \sqrt{\frac{c [N/m]}{m [kg]}}$$

This results in the spring rate c (total system):

$$(3) \quad c [N/mm] = 1000x \left(\frac{f [Hz]}{2\pi} \right)^2 \times m [kg]$$

2. Spring calculation:

Rectangular spring



$$F_{acc} = \frac{bt^2}{6} \cdot \frac{\sigma_{b,acc}}{l}$$

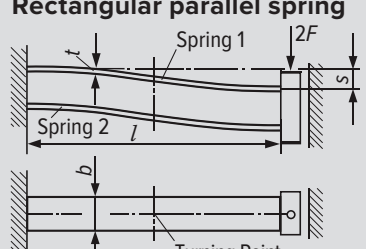
$$s = \frac{Fl^3}{3EI} = \frac{4Fl^3}{bt^3 E}$$

$$s_{acc} = \frac{2l^2 \sigma_{b,acc}}{3t E}$$

$$c = \frac{F}{s} = \frac{bt^3 E}{4l^3}$$

$$W = \frac{btl}{18E} \sigma_b^2; \quad \eta_A = \frac{1}{9}$$

Rectangular parallel spring



$$2F_{acc} = 2 \cdot \frac{bt^2}{3} \cdot \frac{\sigma_{b,acc}}{l}$$

$$s = \frac{Fl^3}{12EI} = \frac{Fl^3}{bt^3 E}$$

$$s_{acc} = \frac{l^2 \sigma_{b,acc}}{3t E}$$

$$c = \frac{bt^3 E}{l^3} \text{ per spring}$$

$$W_{ges} = 2 \frac{btl}{18E} \sigma_b^2; \quad \eta_A = \frac{1}{9}$$

The most common configuration has springs that are mounted as a trapezium with an S-shaped deflection.

In which case, the spring thickness t is calculated as follows (n is the number of support points / springs over which the total spring constant is distributed, and for a single spring $n = 1$):

$$(4) \quad t = \sqrt[3]{\frac{c \times l^3}{b \times E \times n}}$$

3. Checking the max. bending stress σ_b :

$$(5) \quad \sigma_b = \frac{3 \times E \times t \times s}{l^2}$$

S-Ply® yellow ($E = 28,000 \text{ N/mm}^2$; $\sigma_{b(acc.)} = 138 \text{ N/mm}^2$)

S-Ply® blue ($E = 28,000 \text{ N/mm}^2$; $\sigma_{b(acc.)} = 138 \text{ N/mm}^2$)

S-Ply® carbon ($E = 100,000 \text{ N/mm}^2$; $\sigma_{b(acc.)} = 315 \text{ N/mm}^2$)

If the value reached for σ_b does not exceed the allowed value of $\sigma_{b(acc.)}$, the spring is suitable for a vibratory conveyor. However, if the value is exceeded, damage (delamination or breakage) due to overuse can occur.

The following design changes are possible:

- Increase of free spring length l
- Increase in the number of support points
- Installation of more springs per support point.

4. Replacement of individual springs:

On reaching the maximum allowed bending stress [N/mm^2] it is acceptable to replace single springs of thickness t_1 with spring assemblies comprising n individual springs of thickness t_2 :

$$(6) \quad t_2 = \sqrt[3]{\frac{t_1^3}{n}}$$

5. Replacement of springs:

(e.g. for steel or GRP alternative products)

The following conversion applies where n = number of steel springs:

$$t_{S-Ply} = t_{Steel} \times \sqrt[3]{\frac{n_{Steel} \times E_{Steel}}{E_{S-Ply}}}$$

For a "one to one" conversion, $n=1$.

With steel leaf springs in particular, several springs (spring assemblies) can usually be replaced by one S-Ply leaf spring, but to confirm this the bending stress must be checked, as described in Section 3 above.